Implementation of an online HIV prevention and treatment cascade in Thai men who have sex with men and transgender women using Adam's Love Electronic Health Record system

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Abstract

Objectives: Electronic health record (EHR) systems have been infrequently used to support HIV service delivery models to optimise HIV prevention and treatment cascades. We have studied the implementation, uptake and use of an EHR among Thai men who have sex with men (MSM) and transgender (TG) women.

Methods: Participants, e-counselled via the Adam's Love (www.adamslove.org) support platforms, after having completed risk behaviour questionnaires and being assessed for their HIV risk by online counsellors, were enrolled based on their preference into one of three EHR-supported arms: (1) private clinic-based HIV testing and counselling (HTC); (2) online pretest counselling and private clinic-based HIV testing (hybrid); and (3) online supervised HIV self-testing and counselling (eHTC).

Results: Between December 2015 and May 2016, of a total of 489 MSM and TG women were introduced to the study, 186 (38%) enrolled into the study, with 89, 72 and 25 participants joining the HTC, hybrid and eHTC arms, respectively. Seeking sex online was reported by 83.9%. HIV prevalence was highest (16%) in the eHTC arm, and participants in this arm were more likely to be younger (median age 25 *vs* 29 *vs* 27 years; *P*=0.01), bisexual (16% *vs* 9.7% *vs* 5.6%; *P*=0.005), with an unknown history of HIV or first-time HIV testers (48% *vs* 25% *vs* 19.1%; *P*=0.01) or had tested >1 year ago (15.8% *vs* 4.8% *vs* 3.4%, *P*=0.04), compared with those in the hybrid and HTC arms. Around half (48.3%) of them revisited the EHR at least once to access laboratory results, read post-test summaries and make an appointment for another HIV test. The participants in the eHTC arm had reduced odds of revisiting the EHR twice or more as compared with participants in the HTC [odds ratio (OR) 0.14, 95% confidence interval (CI) 0.03–0.67, *P*=0.01] and hybrid arms (OR 0.10, 95% CI 0.02–0.44, *P*=0.003). Overall the EHR satisfaction was high at 4.4 (SD 0.68) on a Likert scale of 5.

Conclusions: Young and high-risk MSM and some TG women engaged successfully with the Adam's Love EHR system, showing its potential to support innovative service delivery models and target hard-to-reach and vulnerable populations.

Keywords: Electronic health record, health informatics, HIV testing, HIV prevention and treatment cascade, men who have sex with men, transgender women, Thailand

Introduction

In Thailand, men who have sex with men (MSM) and transgender (TG) women account for the largest number of new HIV infections. In Bangkok, one in three MSM is infected with HIV [1], and incidence rates, especially among young MSM aged 15–21 years, are alarmingly high (12.2 per 100 person-years) [2]. Thailand aims to end the AIDS epidemic by 2030. Mathematical modelling suggests that the only way to achieve this goal is to increase HIV testing to cover 90% of key populations [3] and to treat all HIV cases with antiretroviral therapy (ART) regardless of the CD4 count.

A major priority in strategic planning is to test more individuals and treat all of them on the recruit–test–treat–retain cascade. However, the HIV testing rate, the first critical step to ending the epidemic in particular among MSM populations, remains very low at 29% [4]. Only 7% of those reached through conventional face-to-face outreach activities have been tested for HIV [5], and in most conventional HIV testing programmes less than 50% who come for HIV testing are first-time testers [6].

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Among Thai HIV-positive individuals in the National AIDS Program, only 73% have started ART and almost half of them had CD4 counts below 100 cells/mm^3 at treatment initiation [7]. The overall retention rate in the programme is 78%, with a higher rate (87%) among those who are on ART than in those who are not (31%) [7].

A number of structural, societal and individual factors are barriers in terms of optimising the HIV prevention and treatment cascade among MSM and TG women. These include traditional low rate of outreach models [5,8], sexual identity and HIV-related stigmatisation [9], conventional HIV testing facilities with long waiting times, ineffective linkage to HIV care models, lack of adherence and retention support strategies [10,11], fragmented healthcare systems [12], perceived discrimination from providers, poor patient–provider communication, lack of guidance and follow-up, and logistic barriers [13–15]. Innovative interventions and service delivery models that help optimise this cascade by overcoming these barriers are a priority.

Electronic health record (EHR) systems are one example of an emerging healthcare technology that helps to reduce the fragmentation of care. They empower clients to engage in their own care, communicate with providers in virtual non-judgemental settings, schedule appointments and access medical health records by providing clients instant personal health information (PHI). Such models have become an important part of healthcare delivery, especially in the west [16].

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However, the potential of EHR in optimising the HIV prevention and care cascade, especially among MSM and TG women, remains unknown. Past use has been limited, focusing primarily on removing the need for local clinic infrastructure, enhancing data sharing, providing a centralised source of data for epidemiological research [17] and reducing gaps, specifically in the HIV treatment continuum [18]. Costs, fear of and actual data breaches, as well as securing client confidentiality [19–22], remain key challenges to EHR adoption and effective use, especially among populations with stigmatising health conditions [23–25].

Adam's Love (www.adamslove.org), a leading technology-based HIV outreach and testing initiative in Asia for MSM and TG individuals, was launched in 2011 by The Thai Red Cross AIDS Research Centre (TRCARC) and has engaged more than 3 million website visitors since its launch [26–28]. It has demonstrated success in engaging hard-to-reach Thai and Asian MSM and TG groups in e-counselling, assessing risks in real time and effectively linking them online to relevant clinical services using its novel online-to-offline model [26,28–34]. These vulnerable groups with high Internet and technology literacy could further benefit from innovative models such as the EHR.

We have developed and launched the Adam's Love EHR system in an effort to facilitate a completely online HIV prevention and treatment cascade. Because data on EHR implementation and impact on MSM and TG women's health are scarce, this study hopes to describe the implementation of a system that supports different types of HIV service delivery models and analyse participant characteristics according to their choice of EHR-supported service delivery model. We also have examined the factors associated with EHR uptake and utilisation among various MSM and TG subgroups and its impact on their health-seeking behaviours for six months following implementation, as well as the costs involved in the design and implementation of the system, to provide recommendations for future enhancements.

Methods

The myhealth.adamslove.org, a web browser-based EHR system, a recent addition to Adam's Love, was launched by the TRCARC in December 2015 [35] as part of the Online Test and Treat Study approved by the institutional review board of the Faculty of Medicine, Chulalongkorn University in Bangkok, Thailand, an amfAR GMT Initiative implementation science research project.

Between December 2015 and May 2016, the e-counselling support delivered via Adam's Love integrated e-platforms, including Adam's Love website (www.adamslove.org), social media networks and instant messaging applications helped engage MSM and TG individuals at risk. They completed risk behaviour questionnaires and were assessed for their risk by Adam's Love online counsellors and staff who introduced them to the Adam's Love clinic-based or home-based HIV testing and counselling service options, and enrolled them into one of three study arms of their choice: (1) Participants in the HIV testing and counselling (HTC) arm received HIV testing and counselling at the MSM- and TG-friendly Adam's Love private and by-appointment clinic and were given access to the EHR system post HIV testing; (2) The participants in the hybrid arm received online pretest counselling, scheduled appointments via EHR and visited Adam's Love clinic to perform HIV testing; and (3) Participants in the online supervised HIV self-testing and counselling (eHTC) arm completed all of the above online via Adam's Love EHR, including scheduling for real-time home-based HIV testing and guidance, pretest counselling, online supervised finger-prick HIV self-testing and online referral to HIV treatment sites for those diagnosed as HIV positive (Box 1).

The Adam's Love EHR model allowed a real-time data collection for study and monitoring purposes. Data elements can be categorised into the following items: (1) sociodemographic data: age, sexual identity, education, income, sexual and drug use behaviours, social network use characteristics, HIV and sexually transmitted infection (STI) testing history were self-reported in the questionnaires completed by participants; (2) EHR utilisation and activity tracking of participants in the HTC, hybrid and eHTC arms: appointment schedule and actual testing, time stamps, login frequency, functions accessed, EHR satisfaction, EHR system errors, troubleshooting and maintenance, and recommended engagement strategies needed were gathered using EHR data metrics and participant-completed questionnaires; and (3) clinical and laboratory data: HIV test results were entered manually in the EHR system by clinic counsellors and nurses.

Statistical analysis was conducted with Stata 14 (StataCorp LP, College Station, TX, USA). Sociodemographic and subject behavioural characteristics of participants in each arm were compared using a Kruskal–Wallis test for continuous covariates and chi-square or Fisher's exact tests for categorical covariates. Thereafter multiple logistic regression was used to assess which participant characteristics were associated with revisiting the EHR twice or more. Covariates in univariate analysis where the P for one of the categories *vs* the reference group was <0.1 were adjusted for in a multivariate model.

Development of Adam's Love EHR

The Adam's Love EHR was developed using an IBM web server application with steadfast security that included intuitively designed

Box 1. Description of the three electronic health record (EHR)-supported HIV service delivery models

	HIV testing and counselling (HTC) arm	Hybrid arm	Online supervised HIV self-testing and counselling (eHTC) arm
Scheduling an appointment	Use e-counselling support platform to schedule HTC at a private Adam's Love clinic	Use EHR to schedule online pretest counselling Use EHR to schedule HIV testing at an Adam's Love clinic	Use EHR to schedule online pretest counselling Use EHR to schedule the delivery of an HIV self-testing kit Use EHR to schedule online supervised HIV testing
Pretest counselling	At Adam's Love clinic	Online pretest counselling via live video	Online pretest counselling via live video
HIV testing	At Adam's Love clinic	At Adam's Love clinic	Online supervised HIV self-testing with real-time guidance by counsellor
Post-test counselling	At Adam's Love clinic, along with registration into the EHR system	At Adam's Love clinic	Online post-test counselling

All participants received e-counselling via Adam's Love online support platforms (such as web message boards, social networks, instant communication applications), complete risk behaviour questionnaires and were assessed for their risk by online counsellors prior to being introduced to the study and choosing their preferred arm.
Registered participants in all three arms received access to all EHR features and functionalities illustrated in Figure 1.

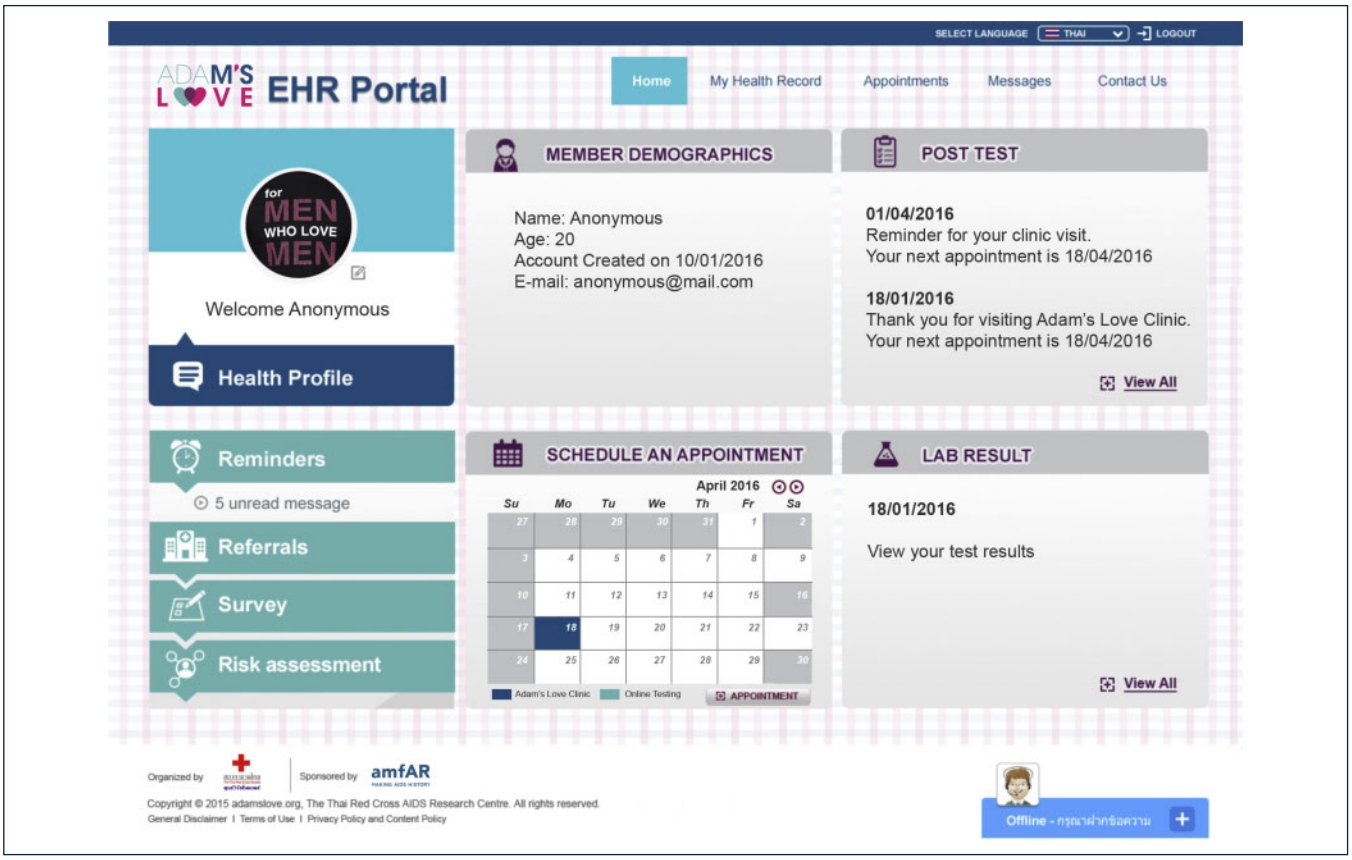

Figure 1. Adam's Love Electronic Health Record (EHR) features and functions

displays, aligned with cognitive workflows and decision making, which offered participants multiple user-friendly functions and features. The system was shaped and conceptualised by the study team, including HIV prevention and technology leaders, clinicians, biostatisticians and public health professionals, with the aim of facilitating an optimal online HIV prevention and treatment cascade as illustrated above (Figure 1).

Key features of the system

– *Online consent, knowledge assessment and registration*

ability to conduct online consent by electronic signature, test eligibility and participant understanding prior to joining the study; collect personal sociodemographic details during registration process and send signed consent form copies to the EHR database, project team and participant's email; issue EHR personal identification number; and conduct multiple surveys and self-risk assessment.

– *Appointment scheduling/rescheduling and cancellation*

e-calendar with the ability to display available date and time slots for services at Adam's Love private clinic sites; enable participants to create, reschedule, or cancel appointments for pretest e-counselling, home-based HIV testing with live online guidance or Adam's Love clinic-based offline HIV testing.

– *Synchronous e-counselling*

enable participants to communicate electronically and securely with counsellors through web conferencing, online meetings, screen sharing, live chats, and receive real-time HIV testing guidance and e-counselling.

– *Post-test summary, laboratory results and health records:*

enable participants to check their post-test summaries; access past HIV/STI test and other laboratory results such as CD4 count, HIV-RNA level, history of ART medication and other PHI data collected and entered manually by Adam's Love clinic counsellors and nurses in the EHR system; and view auto-generated graphs showing CD4 counts and HIV-RNA levels over time (Figure 2).

– *Reminders and messages*

automated appointment reminders and personalised messaging capabilities to engage and retain participants in care.

– *ART hospital referrals*

ability to facilitate the early linkage to care at one of the five collaborative hospitals for ART initiation, enable online registration with the linked HIV treatment facility, share participants' HIV results and related health records with linked ART hospital nurses and provide a registration code online allowing a fast-track access to HIV treatment providers.

– *Data storage and security*

The EHR system designed and built using IBM WebSphere Portal and DB2 database server included a range of steadfast security features to prevent unauthorised intrusion and help ensure secure data storage and back-up, participant access and sensitive HIV/STI data protection (Figure 2).

EHR usability training was conducted for participants, moderators, counsellors and ART hospital staff who were assigned various levels of access and authorisation permissions based on their administrative roles.

Results

Between December 2015 and May 2016, a total of 489 e-counselled MSM and TG women were assessed for their risk and introduced to the study arms by online counsellors, of whom 186 (38%) enrolled into the Adam's Love EHR system. Of the enrolled

Figure 2. Adam's Love Electronic Health Record (EHR) advanced data security system and one-time password (OTP) verification. Advanced security features included an email verification process and a two-factor authentication (2FA) ensured by an OTP for real-time validation during the registration process and each time participants accessed clinical and laboratory test results

participants, 89, 72 and 25 chose to join the HTC, hybrid and eHTC arms, respectively, with an age range of 17–50 years (Table 1).

The majority (>80%) of participants in the three arms had obtained bachelor degrees or higher, more than a quarter had a monthly salary above 1000 USD, most (>72%) lived in Bangkok, a majority (>69.7%) spent more than 4 hours using social media and most (83.9%) had sought sex online. Almost one-third (>30%) had used drugs in the past 6 months, mostly alcohol (>54%), poppers (>25%) and Viagra (>8%), with popper use highest among participants in the hybrid arm (54.5%). Those in the HTC arm as compared with those in the hybrid and eHTC arms were more likely to self-identify as gay (88.8%, P=0.005), spent more than 8 hours per day on social media (55.1% *vs* 29.2% *vs* 24%, P<0.001), consistently used condoms in the past 6 months (60.7% *vs* 23.9% *vs* 28%, P<0.001) and had been previously diagnosed with an STI compared with those in the other two arms (27% *vs* 11.1% *vs* 20%, P=0.02), respectively.

The participants in the eHTC arm were more likely to be younger, with a median age of 25 *vs* 29 for the hybrid and 27 years for the HTC arm (P=0.01), bisexual (16% *vs* 9.7% *vs* 5.6%, P=0.005), have never tested for HIV or refused to answer (48% *vs* 25% *vs* 19.1%; P=0.01) or tested more than 1 year ago (15.8% *vs* 4.8% *vs* 3.4%, P=0.04). The participants in the eHTC and hybrid arms tended to have had more group sex (16% *vs* 15.3% *vs* 5.6%; P=0.10) than did those in the HTC arm, although this difference was not significant. The participants in the eHTC arm had never used methamphetamine, although some in the HTC (11.1%) and hybrid (13.6%) arms reported having used it.

Platforms used for seeking sex varied significantly among the three arms, with Camfrog (video chat program) having the highest use among participants in the eHTC arm (P=0.003); Jack'd (P<0.001), Hornet (P=0.002) and Grindr (P<0.001) dating applications had the highest use among participants in the hybrid arm; and Twitter (social networking application) was highest among participants in the HTC arm (P=0.002).

HIV prevalence was highest among participants in the eHTC arm (16% *vs* 1.4% *vs* 2.2%, P=0.01). However, none of the study's five collaborative treatment sites for online referral was covered by the national health insurance plan, which is based on the national identification number and address in Thailand of the HIV-positive participant. These individuals were successfully linked to care through conventional offline referral methods rather than the online model via the EHR's electronic referral system.

The median (interquartile range) duration of study follow-up was 2.3 (1.8–5.9) months and is consistent across arms. Almost half of all participants in the HTC (48.3%), hybrid (62.5%) and eHTC (48%) arms revisited the EHR at least once after baseline registration. The median revisit time was 4 *vs* 4 *vs* 6 days, respectively. The second revisit rate was least among participants in the eHTC arm (8%), whereas more than a quarter of the participants in the HTC (27%) and hybrid (26.4%) arms revisited three or more times. Participants in the HTC, hybrid and eHTC arms revisited to check messages sent by the study team (90.7% *vs* 82.2% *vs* 41.7%, P=0.002), access laboratory results (79.1 *vs* 71.1% *vs* 33.3%, P=0.01), read post-test counselling summaries (53.5% *vs* 55.6% *vs* 33.3%) and make their next clinic appointment to receive an HIV test (51.2% *vs* 66.7% *vs* 0%, P<0.001) (Table 2).

In a multivariate model adjusting for sexual identity, three factors were independently associated with more than two EHR revisits. Participants in the eHTC arm had reduced odds of revisiting compared with participants in the HTC [odds ratio (OR) 0.14, 95% confidence interval (CI) 0.03–0.67, P=0.01] and hybrid arms (OR 0.10, 95% CI 0.02–0.44, P=0.003). Those having an income of ≤500 USD (OR 4.21, 95% CI 1.21–14.71, P=0.02) or between 501 and 1000 USD (OR 3.38, 95% CI 1.04–11.03, P=0.04) *vs* ≥1500 USD per month, and those having group sex in the past 6 months (OR 3.71, 95% CI 1.16–11.81, P=0.03), had increased odds for revisiting the EHR twice or more. None of the participants who were diagnosed as HIV positive ever revisited on two or more occasions (Table 3).

The majority of participants (n=110) who accessed the EHR system also completed the satisfaction survey. Overall satisfaction was

Table 1. Sociodemographics of participants in the HTC, hybrid and eHTC arms

Characteristics	HTC	Hybrid	eHTC	*P*-value
	N=89	*N*=72	*N*=25	
	N (%)	*N* (%)	*N* (%)	
Age, year				0.01
Median (IQR)	27 (23–32)	29 (25–35)	25 (23–28)	
[Min–Max]	[17–50]	[19–49]	[20–43]	
Sexual orientation				0.005[a]
Gay	79 (88.8)	53 (73.6)	14 (56.0)	
Bisexual	5 (5.6)	7 (9.7)	4 (16.0)	
Male	3 (3.4)	10 (13.9)	4 (16.0)	
Transgender	2 (2.2)	2 (2.8)	3 (12.0)	
Education level				0.995
Less than bachelor's degree	17 (19.1)	14 (19.4)	5 (20.0)	
Bachelor's degree or higher	72 (80.9)	58 (80.6)	20 (80.0)	
Monthly income				0.82
≤500 USD	24 (27.0)	17 (23.6)	6 (24.0)	
501–1000 USD	42 (47.2)	31 (43.1)	10 (40.0)	
≥1001 USD	23 (25.8)	24 (33.3)	9 (36.0)	
HIV test result				
Negative	87 (97.8)	71 (98.6)	21 (84.0)	0.01[a]
Positive	2 (2.2)	1 (1.4)	4 (16.0)	
Current residence				0.59
Bangkok	72 (80.9)	55 (76.4)	18 (72.0)	
Others	17 (19.1)	17 (23.6)	7 (28.0)	
Time spent on social media per day				<0.001
Less than 4 hours	27 (30.3)	21 (29.2)	6 (24.0)	
4–8 hours	13 (14.6)	30 (41.7)	13 (52.0)	
8–24 hours	49 (55.1)	21 (29.2)	6 (24.0)	
Seek sexual partners online				0.53
No	17 (19.1)	9 (12.5)	4 (16.0)	
Yes	72 (80.9)	63 (87.5)	21 (84.0)	
Online/social media channels to seek sex	*N*=72	*N*=63	*N*=21	
Facebook	37 (51.4)	26 (41.3)	8 (38.1)	0.38
Grindr	17 (23.6)	53 (84.1)	12 (57.1)	<0.001
Hornet	45 (62.5)	55 (87.3)	12 (57.1)	0.002
Jack'd	37 (51.4)	55 (87.3)	15 (71.4)	<0.001
Camfrog	15 (20.8)	6 (9.5)	9 (42.9)	0.003
Twitter	10 (13.9)	0 (0.0)	0 (0.0)	0.002[a]
Instagram	8 (11.1)	2 (3.2)	1 (4.8)	0.18[a]
Others (BeeTalk, GROWLr, PlanetRomeo)	3 (4.2)	1 (1.6)	0 (0.0)	0.79[a]
Ever tested for HIV				0.01[a]
Did not answer	0 (0.0)	10 (13.9)	6 (24.0)	
Yes	72 (80.9)	54 (75.0)	13 (52.0)	
No	17 (19.1)	8 (11.1)	6 (24.0)	
Previous HIV test	*N*=89	*N*=62	*N*=19	0.04[a]
Never tested	17 (19.1)	8 (12.9)	6 (31.6)	
Less than 6 months	57 (64.0)	34 (54.8)	7 (36.8)	
6 months–1 year	12 (13.5)	17 (27.4)	3 (15.8)	
>1 year	3 (3.4)	3 (4.8)	3 (15.8)	

Table 1. *Continued*

Characteristics	HTC	Hybrid	eHTC	*P*-value
	N=89	*N*=72	*N*=25	
	N (%)	*N* (%)	*N* (%)	
Lifetime sexual relationship with				
Male	89 (100.0)	72 (100.0)	25 (100.0)	N/A
Female	16 (18.0)	13 (18.1)	5 (20.0)	0.934[a]
Transgender	2 (2.2)	0 (0.0)	2 (8.0)	0.07[a]
Condom use in the past 6 months				<0.001
Always	54 (60.7)	17 (23.9)	7 (28.0)	
Sometimes	23 (25.8)	50 (70.4)	16 (64.0)	
Never	9 (10.1)	3 (4.2)	2 (8.0)	
No anal sex in the past 6 months	3 (3.4)	1 (1.4)	0 (0.0)	
Substance use in the past 6 months (including alcohol)				0.40
No	53 (59.6)	50 (69.4)	17 (68.0)	
Yes	36 (40.4)	22 (30.6)	8 (32.0)	
Substance used in the past 6 months	*N*=36	*N*=22	*N*=8	
Alcohol	20 (55.6)	12 (54.5)	6 (75.0)	0.64[a]
Poppers	17 (47.2)	12 (54.5)	2 (25.0)	0.42[a]
Methamphetamine	4 (11.1)	3 (13.6)	0 (0.0)	0.86[a]
Ketamine	0 (0.0)	1 (4.5)	0 (0.0)	0.46[a]
Viagra	3 (8.3)	4 (18.2)	1 (12.5)	0.50[a]
Cannabis	1 (2.8)	1 (4.5)	0 (0.0)	0.81[a]
Reasons for using substance	*N*=31	*N*=21	*N*=7	
Sexual arousal	10 (32.3)	9 (42.9)	3 (42.9)	0.69[a]
Forget sadness	0 (0.0)	3 (14.3)	0 (0.0)	0.08[a]
Try/friends recommend	4 (12.9)	5 (23.8)	0 (0.0)	0.40[a]
For fun	15 (48.4)	12 (57.1)	5 (71.4)	0.53[a]
Dare to do things	0 (0.0)	1 (4.8)	0 (0.0)	0.48[a]
Prolong sex	2 (6.5)	0 (0.0)	0 (0.0)	0.62[a]
Ever had an STI				0.02[a]
Never	52 (58.4)	51 (70.8)	20 (80.0)	
Yes	24 (27.0)	8 (11.1)	5 (20.0)	
I'm not sure	13 (14.6)	13 (18.1)	0 (0.0)	
Had group sex in the past 6 months				0.10
No	84 (94.4)	61 (84.7)	21 (84.0)	
Yes	5 (5.6)	11 (15.3)	4 (16.0)	

eHTC: online supervised HIV self-testing and counselling; HTC: private clinic-based HIV testing and counselling; IQR: interquartile range; STI: sexually transmitted infection.
[a] Fisher's exact test.

reported to be high, with a mean rating of 4.4 (SD=0.68) on a Likert scale of 5. Participants also favourably rated each existing EHR feature, including design and comprehensive interface (4.34, SD=0.78), online consent and understanding (4.58, SD=0.57), ease of registration process (4.51, SD=0.63), online HIV/STI data security (4.64, SD=0.53), ease of accessing laboratory results and post-test counselling summaries (4.37, SD=0.70) and the video chat quality for online HIV self-testing guidance (4.71, SD=0.47). Future and most desirable EHR enhancement features were real-time e-counselling by doctors, a sexual health forum, educational videos, a reward and incentive structure for achieving milestones, a personalised memo/diary to maintain health notes and chat rooms to connect with the community.

In total there were 24 incidents (12.9% user incident reports) reported during the 6-month period, including interoperability issues, survey completion errors, e-calendar scheduling issues, booking viewing made at e-calendar and some other interface issues. There were also initial technical difficulties with the one-time password (OTP) system due to password delivery interruptions. These were addressed by troubleshooting directly with local mobile network operators and white listing internet protocol numbers. Other technical issues included inconsistent microphone or webcam function and disruptions in live video chat due to slow internet connections.

Discussion

Our study demonstrates the feasibility of creating an innovative EHR system tailored for MSM and TG women. Three different types of service delivery models helped reach diverse and at-risk subgroups of mostly MSM, varying by age, time spent per day

Table 2. EHR utilisation among participants in the HTC, hybrid and eHTC arms

EHR utilisation	HTC (*n*=89)	Hybrid (*n*=72)	eHTC (*n*=25)	*P*-value
Revisit after baseline				
No	46 (51.7)	27 (37.5)	13 (52.0)	0.17
Yes	43 (48.3)	45 (62.5)	12 (48.0)	
Number of EHR revisits after baseline (times)				0.001[a]
0	46 (51.7)	27 (37.5)	13 (52.0)	
1	9 (10.1)	11 (15.3)	10 (40.0)	
2	10 (11.2)	15 (20.8)	2 (8.0)	
≥3	24 (27.0)	19 (26.4)	0 (0.0)	
Duration between baseline and first revisit (days)	*N*=43	*N*=45	*N*=12	0.627
Median (IQR)	4 (1–8)	4 (2–11)	6 (2–12)	
[Min–Max]	[1–72]	[1–71]	[1–27]	
EHR activities at revisit	*N*=43	*N*=45	*N*=12	
Check messages	39 (90.7)	37 (82.2)	5 (41.7)	0.002[a]
Check lab results	34 (79.1)	32 (71.1)	4 (33.3)	0.01[a]
View post-test summary	23 (53.5)	25 (55.6)	4 (33.3)	0.41[a]
Appointment making	22 (51.2)	30 (66.7)	0 (0.0)	<0.001
Complete survey	5 (11.6)	10 (22.2)	7 (58.3)	0.004[a]

EHR: electronic health record; eHTC: online supervised HIV self-testing and counselling; HTC: private clinic-based HIV testing and counselling; IQR: interquartile range.
[a] Fisher's exact test.

using social media, substance use, online sex-seeking behaviours, condom use, and HIV/STI testing history and prevalence. Of a total of 186 MSM and TG participants enrolled in the study, nearly one-third had used substances, most had sought sex online and a quarter of them were first-time testers. Almost half (48.3%) revisited the EHR at least once to access laboratory results, read post-test summaries and make an appointment for their next HIV test. The overall satisfaction with the system was reported to be high by all participants. Young, bisexual and high-risk MSM and TG women with high psychotropic drug use, had more group sex and who never or less frequently tested for HIV were more likely to prefer the eHTC or hybrid arm. The HIV prevalence was highest (16%) in the eHTC arm. The EHR-supported innovative online and offline service delivery models ensured secure and safe access to highly sensitive HIV/STI data storage and access over the Internet. The platform has, therefore, a high potential to store and enable access to cascade data for both HIV prevention and treatment programmes.

Several studies have demonstrated that many participants would review and interact with their medical record on an ongoing basis if the record was made available to them [36–39].

Usage and revisits were highest among participants in the hybrid arm who used this system for checking laboratory results, checking post-test counselling summaries and making appointments for their next clinic visit, representing, therefore, possibly the most feasible, acceptable and engaging model for high-risk Thai MSM and TG groups who have high Internet and technology utilisation, and those who use multiple applications to seek sex online and those who engage in group sex.

Interestingly in our multivariate model analysis, those with a lower monthly income who would be less likely to afford private healthcare were more likely to revisit the EHR on two or more occasions. It is possible that they felt more engaged and empowered by our innovative model than they did in the traditional healthcare systems, where they might feel hesitant in communicating with providers and in seeking support due to multiple barriers, including differences in social status and self-stigmatisation perceptions towards the use of these services [40–42]. Provision of virtual and non-judgemental medical services and easy and free access to PHI via EHR for vulnerable groups with lower socio-economic status could help reduce health disparities.

The participants in the eHTC arm had the least number of EHR revisits, with those diagnosed as HIV positive especially hard to engage online. This may be due to a lack of in-person counselling post HIV testing and an insufficient interaction/relationship building with the offline counsellors. We were unable to refer and link online via the EHR those who were diagnosed positive in the eHTC arm. They were linked via the offline referral system to treatment sites covered by their healthcare coverage plans, which might also be a factor for reduced engagement and EHR utilisation.

Evidence of the impact EHRs have on clinical outcomes remains mixed in diabetes [43] and HIV care. These systems have shown a potential to improve quality of care [44] and communication between patients and providers [45] as well as ART adherence [46]. In our study the EHR integrated with innovative service delivery models helped improve client engagement in terms of their health and reduce some of the known barriers in conventional HIV prevention and care models.

The absence of meaningful end-user engagement has repeatedly been highlighted as a key factor contributing to 'failed' EHR implementations [47]. Our participants highlighted the importance of integrating user-driven engagement strategies to enhance the involvement in their health and increase interactions with providers to improve health outcomes.

We are aware of several limitations in our study. Participants in the eHTC arm diagnosed as HIV positive had to be linked to care by offline referral systems as the collaborative treatment sites that supported the online referral and linkage to care were not covered by the participant's national healthcare plan. A wider collaboration with other treatment sites in Bangkok to facilitate online linkage

Table 3. Univariate and multivariate analysis of factors associated with revisiting the EHR at least twice

Covariate	Did not revisit or revisit once	Revisit (≥2 times)	Unadjusted OR (95%CI)	*P*	Adjusted OR (95%CI)	*P*
Arm				0.001		0.002
HTC	55 (61.8)	34 (38.2)	Reference		Reference	
Hybrid	38 (52.8)	34 (47.2)	1.45 (0.77–2.72)	0.25	1.38 (0.70–2.72)	0.35
eHTC	23 (92.0)	2 (8.0)	0.14 (0.03–0.63)	0.01	0.14 (0.03–0.67)	0.01
Sexual orientation				0.33		0.44
Gay	87 (59.6)	59 (40.4)	Reference			
Bisexual	13 (81.2)	3 (18.8)	0.34 (0.09–1.25)	0.68	0.34 (0.09–1.38)	0.13
Male	11 (64.7)	6 (35.3)	0.80 (0.28–2.29)	0.54	1.08 (0.32–3.60)	0.90
Transgender	5 (71.4)	2 (28.6)	0.59 (0.11–3.14)	0.10	0.87 (0.13–5.56)	0.89
Education level				0.58		
Less than bachelor's degree	21 (58.3)	15 (41.7)	1.69 (0.64–4.44)			
Bachelor's degree or higher	95 (63.3)	55 (36.7)	Reference			
Monthly income				0.19		0.11
≤500 USD	26 (55.3)	21 (44.7)	3.23 (1.04–10.06)	0.04	4.21 (1.21–14.71)	0.02
501–1000 USD	50 (60.2)	33 (39.8)	2.64 (0.90–7.73)	0.08	3.38 (1.04–11.03)	0.04
1001–1500 USD	20 (64.5)	11 (35.5)	2.20 (0.65–7.49)	0.21	3.00 (0.78–11.59)	0.11
≥1500 USD	20 (80.0)	5 (20.0)	Reference		Reference	
Anti-HIV result				0.05[a]		
Negative	109 (60.9)	70 (39.1)	Reference			
Positive	7 (100.0)	0 (0.0)	0.16 (0–1.12)			
Time using social media per day				0.57		
Less than 4 hours	35 (64.8)	19 (35.2)	Reference			
4–8 hours	37 (66.1)	19 (33.9)	0.95 (0.43–2.08)	0.89		
8–24 hours	44 (57.9)	32 (42.1)	1.34 (0.64–2.75)	0.43		
Condom use in the past 6 months				0.86		
Always/no anal sex in the past 6 months	52 (63.4)	30 (36.6)	Reference			
Sometimes/never	64 (62.1)	39 (37.9)	1.06 (0.58–1.93)			
Used substance in the past 6 months (including alcohol)				0.50		
No	77 (64.2)	43 (35.8)	Reference			
Yes	39 (59.1)	27 (40.9)	1.24 (0.67–2.30)			
Had group sex in the past 6 months				0.10		0.03
No	107 (64.5)	59 (35.5)	Reference		Reference	
Yes	9 (45.0)	11 (55.0)	2.22 (0.87–5.65)		3.71 (1.16–11.81)	
Ever had an STI				0.76		
No	75 (61.0)	48 (39.0)	Reference			
Yes	25 (67.6)	12 (32.4)	0.75 (0.34–1.63)	0.47		
I'm not sure	16 (61.5)	10 (38.5)	0.98 (0.41–2.33)	0.96		

EHR, electronic health record; eHTC, online supervised HIV self-testing and counselling; HTC, private clinic-based HIV testing and counselling.
[a] OR is the median unbiased estimate calculated using exact logistic regression.

to care facilities is our next focus. We also believe that we reached only few TG women, and more efforts are needed to engage this high-risk group in our type of intervention.

The Adam's Love EHR system performed with no unauthorised data breaches, intrusions detected or reported. A combination of security features in its implementation offered layers of protection to the client data and usage. The OTP verification system (two-factor authentication) was acceptable and added further credibility. Contrary to previous EHR studies [25], our quantitative data revealed that Adam's Love EHR system was perceived extremely secure by MSM and TG participants who were highly satisfied with it. This system was extremely robust with 12.9% user incident reports in a six-month period, most being of medium priority and which could be resolved by bug-fixing. The EHR model is scalable and replicable in settings for those who are not reached and for those vulnerable groups with high Internet use. With the capacity to support 1000 users, the investment for our initial set-up was 130,000 USD and the annual post-implementation maintenance cost was 21,100 USD.

In conclusion, our study demonstrated the feasibility of creating a secure and completely online HIV prevention and care cascade using the Adam's Love EHR system. It underlines the significance of implementing such innovative interventions and service delivery models to reach high-risk MSM and some TG women who remain

hard to reach or would shy away from conventional HIV prevention interventions.

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Competing interests

None.

Disclaimer

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Authors' contributions

All authors contributed to the outline of the paper. Tarandeep Anand assumed primary responsibility for writing and revising the manuscript. Nittaya Phanuphak, Chattiya Nitpolprasert, Stephen J Kerr and Tanakorn Apornpong substantially contributed to the preparation of this paper. All authors edited and reviewed the manuscript and gave their final approval for submission to the journal.

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